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Nurse staffing and health care-associated infections: Proceedings from a working group meeting

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The nation is facing a nursing shortage that is creating a crisis for quality health care and patient safety. Research has documented that problems with nurse staffing are associated with health care-associated infections and other adverse events that affect patient outcomes. These ominous facts, stated during the opening of an expert consultants meeting convened by the Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention, laid the foundation for a day-long discussion and a call to action to address a growing crisis in health care. The authors summarize the proceedings of this meeting and present the consultants' suggestions for drawing national attention to this issue. (Am J Infect Control 2002;30:199-206.)

On July 9, 2001, the Division of Healthcare Quality Promotion (DHQP), National Center for Infectious Diseases (NCID), and the Centers for Disease Control and Prevention (CDC) convened the Working Group on Nurse Staffing and Healthcare-Associated Infections in Atlanta, Georgia. The purpose of the meeting was to exchange information and research on the association between health care-associated infections and nurse staffing and to provide input to the CDC and nursing leadership about steps needed to address this issue. Participants included recognized experts in the areas of both nurse staffing and health care-associated infections, as well as representatives of stakeholder organizations (see Appendix).

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DHQP's interest and role in this arena are well established. As noted by Julie Gerberding, MD, MPH, in her opening remarks, DHQP has been given the lead in patient safety activities at CDC and has been designated as a representative to the 4-agency Federal Patient Safety Task Force, which is charged with coordinating the integration of data collection on medical errors and adverse events, coordinating research and analysis, and promoting collaborative efforts to improve patient safety. These activities will contribute to efforts to meet the goal in the 1999 Institute of Medicine[1] report, *To Err Is Human: Building a Safer Health System*, of reducing the number of medical errors by 50% over 5 years.

DHQP also has 7 health care safety challenges to reduce or eliminate targeted health care-associated infections and occupational exposures during the next 5 years. Because the ability to achieve these objectives is highly dependent on a strong infrastructure in health care organizations, DHQP is committed to addressing the essential components of such an infrastructure. Two major factors are likely to influence the potential for success: computer decision support and nurse staffing.

The meeting was organized around 3 basic themes: (1) examination of the scientific evidence on the

relationship between nurse staffing and patient outcomes, (2) understanding system factors that influence nurse staffing, and (3) identifying strategies for effecting change. Formal presentations preceded a discussion of the available information. This article summarizes the proceedings from the meeting and presents several strategies for future action.

NURSE STAFFING AND DEMOGRAPHICS

Peter Buerhaus, PhD, RN, FAAN, provided insight into how increasing societal demands for health care and organizational demands for registered nurses (RNs) will be affected by the changing demographics of the nurse workforce in the United States. Several factors that influence society's growing demand for health care that directly affect the nurse workforce were noted: increasing health care requirements in the aging population and in a growing general population, the presence of more elderly and acutely ill patients in hospitals, increasing use of medical and information technology, current and future economic trends, and national health care policy initiatives. Increasing organizational demands specifically for RNs also can be expected as a result of the regulatory emphasis on quality of care and organizational emphasis on productivity, efficiency, and accountability. The competition for current and future RNs is also influenced by a lack of good RN substitutes.[2-8]

In light of this increasing demand, trends in and forecasts of the future supply of nurses are sobering. The average age of the RN workforce is increasing more than twice as fast as that of all other occupations in the US workforce. Between 1983 and 1998, the number of RNs younger than 30 years decreased by 41%, whereas the number of persons in the US workforce in that age group declined by only 1%. One result of this large decline is that the nurse workforce is dominated by older workers—good news in terms of accumulation of knowledge and experience but bad news in terms of physical endurance. Moreover, conservative projections show a leveling off in total RNs in the workforce in 2008-2009, followed by a decrease as current nurses reach retirement age. Thus, the RN workforce will be shrinking in size while those remaining in the workforce will be significantly older at a time when society will need RNs most, resulting in a large disparity between supply and demand. This gap between supply and demand already is serious in many nursing specialty areas, such as critical care and operating room nursing. The problem is exacerbated by expanding employment opportunities for women in many different fields and declining interest in nursing as a career, particularly among young people.[4,8]

In the past few years, there has been considerable interest in evaluating whether there is a relationship between nurse staffing and patient outcomes. Most recently, Needleman and colleagues[9] reported results of a government-funded study to determine whether there is scientific evidence for a relationship between patient outcomes potentially sensitive to nurse staffing and nurse staffing in inpatient units in acute care hospitals. The researchers analyzed data from more than 5 million hospital discharges in 11 states and more than 12 million Medicare beneficiary discharges in more than 3000 hospitals nationwide in 1997. Strong and consistent relationships were found between nurse staffing variables and 5 outcomes in medical patients (urinary tract infections, pneumonia, length of stay, upper gastrointestinal bleeding, and shock). In patients who underwent major surgery, the only strong and consistent relationship was between nurse staffing and failure to rescue.* For outcomes associated with nurse staffing, higher RN staffing was associated with a 3% to 12% reduction in complication rates.

These findings have generated substantial interest from the public, media, government, policymakers, and special interest groups. This interest will likely focus attention on quality related to hospital nurse staffing, increase demand for regulatory oversight and mandatory staffing requirements, and increase union activity. All of these responses pose additional challenges, given the current nursing shortage and long-term implications of a rapidly aging workforce.

Buerhaus suggested that the overall policy strategy should be to link aging and shortages with nurse staffing and quality rather than viewing them as independent problems. The goal should be to use what is known about health care quality and nurse staffing and for policymakers, health care organizations, nursing and physician leaders, and others to work together to address this critical health care issue. Together, these stakeholders can obtain organizational support and resources to build a better infrastructure that supports nurses in the workforce and make changes to support the nurse education market. Acknowledging that a decreasing supply of

**Failure to rescue* in hospitalized patients is defined as death occurring after an adverse patient occurrence.[10] Factors related to failure to rescue are generally associated with hospital or system characteristics (eg, nurse staffing) rather than patient characteristics.

nurses is inevitable, policymakers will need to prepare for an older workforce, develop better ways to use scarce RNs, prepare for smaller enrollments in schools of nursing, design education for nurses to prepare them for roles in non-hospital settings, and avoid implementing hospital staffing regulations.

Buerhaus identified several strategies to increase the supply of RNs. These include improving the image of nursing, reducing the costs of education, eliminating stigmas and barriers for men and minorities to become nurses, developing ways to retain older nurses in the workforce, and anticipating and preparing for foreign-educated nurses to continue to enter the workforce. To increase the visibility of and public interest in the nurse workforce, policymakers should (a) expand funding for research on the nurse workforce and the impact of nursing on the quality of care; (b) legitimize the problem with high-level attention, such as an Institute of Medicine report, a Department of Health and Human Services commission, and/or a presidential task force; and (c) capitalize on the favorable public opinion of nurses that is widely held by consumers. What we do now to deal with shortages and problems in the nurse workforce will strongly influence the timing and severity of the projected shortage still to come.

RELATIONSHIP BETWEEN NURSE STAFFING AND PATIENT OUTCOMES

Several presenters discussed additional science, published and unpublished, that provides evidence of an association between nurse staffing and patient outcomes. Different research approaches are reflected in the various studies or investigations.

International study on the effects of hospital organization and staffing on patient outcomes

Linda Flynn, PhD, RN, CS, reported on an international study by Aiken and colleagues[11] that focused on the effects of hospital organization and staffing on patient outcomes. The study surveyed 45,300 nurses in 713 hospitals in 5 countries (United States, Canada, Germany, England, and Scotland) about organizational climate, nurse staffing, nurse satisfaction, and patient outcomes. Patient discharge databases were used to derive 30-day mortality and other outcome measures; administrative databases were used to obtain hospital staffing and organizational information. Nurse surveys also were used to derive measures of nurse staffing, organizational characteristics, and nurse and patient outcomes. Survey findings showed that nurses in countries with distinctly different health care systems reported similar shortcomings in their work environments and the quality of patient care. Nurses across countries reported that staffing resources are inadequate, quality of care is not as good as it could/should be, communication between nurses and management is poor, and there is high nurse dissatisfaction. Only 30% to 40% of nurses reported that there are enough RNs to provide high-quality care. A majority of US and Canadian nurses reported that the number of patients assigned to them increased in the past year, and nearly half believed that the quality of patient care in their institutions had deteriorated in the past year. In all countries, many nurses reported spending time performing functions that did not require their professional training, whereas care activities necessitating their skills and expertise were often left undone. Job dissatisfaction was high (more than 40% among US nurses surveyed), and as many as 20% to 40% planned on leaving their jobs within the next year. Fewer than half of the nurses in each country reported that hospital management is responsive to their concerns. These perceptions across countries suggest widespread instability in the global health care nursing workforce.

Nurse survey data were analyzed to determine how nurse and patient outcomes in different hospitals are affected by nurse staffing and nursing organization. Analyses were done both within and across countries. Results showed that hospitals that rated high in staffing and organization in the nurse survey had significantly better patient outcomes. Increased mortality and failure to rescue were associated with lower nurse-assessed quality, increased workload, and lower perception of the hospital organization.

Nurse staffing and health care-associated infections

Mary Blegen, PhD, RN, reviewed the literature on nurse staffing and health care-associated infections.[12-25] Multiple factors influence the development of health care-associated infections, including patient variables (eg, severity of illness, extent of debilitation), care variables (eg, antibiotic use, use of central venous catheters), and organizational variables (eg, staffing). Research that has addressed nurse staffing as a variable affecting patient outcomes comes from 2 directions: (1) research on organizational factors that influence patient outcomes and (2) health care-associated infection outbreak investigations that have evaluated organizational factors that may have contributed to the problem. Regardless of the type of

Table 1. Studies showing an association between nurse staffing and adverse patient outcomes

Author(s)	Data source(s)	Results
American Nurses Association, 1997[12,13]	462 hospitals in New York and California, 1992 and 1994	Increased proportion of RN hours of care were associated with lower infection rates (0.4% to 0.6% decrease in infection rates with a 1% increase in RN proportion of hours of care).
American Nurses Association, 2000[14]	Medicare data from 1500 hospitals in 9 states; all payor data from 1000 hospitals in 6 states	Increased percentages of RNs in the workforce were associated with lower infection rates (0.3% to 0.7% reduction in rates with a 1% increase in proportion of RN hours of care).
Kovner and Gergen, 1998[15]	Surgical patients in 589 hospitals in 10 states	Higher RN staffing (full-time–equivalent RNs/adjusted inpatient-day) was associated with a lower incidence of urinary tract infections and pneumonia.
Needleman et al, 2001[9]	3 hospital samples: 799 hospitals in 11 states; 256 hospital sub-sets from 1 state; national sample of 3357 hospitals	Urinary tract infections were reduced in medical patients by 4% to 12% with a high proportion of RNs and 4% to 25% with high total RN hours. Pneumonia was reduced in medical patients by 6% to 8% with a high proportion of RNs and 6% to 17% with high total RN hours.
Flood and Diers, 1988[16]	2 hospital units	The short-staffed unit had more complications, including general infections and urinary tract infections. The cost of providing care for patients with complications exceeded the cost saved with short staffing.
Blegen et al, 1998[17]	33 patient care units in 1 large hospital	Respiratory and urinary tract infection rates decreased with an increased proportion of RNs and increased with total hours of care.
Giraud et al, 1993[18]	Critical care patients who developed iatrogenic complications in 1 hospital	25% of complications were infections. Patients on the unit when the nursing workload was high developed more complications.

study, the results are generally consistent in showing a relationship between nurse staffing and health care-associated infections.

Four large, multihospital analyses that used national databases to study general infection rates showed a small but consistently positive effect of RN care on hospital-acquired infections[9,12-15]; another group of studies analyzed hospital- or unit-specific data (Table 1).[16-18] The latter provide generally consistent evidence of an association between a higher proportion of RN care and fewer infections.

In studies conducted as part of outbreak investigations, an association between nurse staffing and health care-associated infection was also observed (Table 2).[19-26] Few studies looked at the mechanism of effect (eg, treatment errors and noncompliance with handwashing among nurses with higher workloads and higher work stress).

The conclusions from the literature review are that health care-associated infections result from a multitude of factors. One organizational factor with a consistent effect is the level of RN staffing on patient units. Blegen suggested that there may be a threshold level for RN staffing below which infection rates increase and that staffing with RNs who are not familiar with the unit (eg, pool, agency nurses) may also heighten the infection risk. These conclusions indicate that hospitals must provide adequate RN staffing on patient care units and maintain consistent unit assignments. They also suggest that hospital-associated infection rates at the unit level should be used as a reportable measure of quality. Although most hospitals monitor infections through routine surveillance, not all perform surveillance at the unit level where nurse staffing has the biggest impact.

Effect of organizational factors and nurse staffing on bloodstream infection rates in the Evaluation of Processes and Indicators in Infection Control study

Barbara Braun, PhD, reported on findings from the Evaluation of Processes and Indicators in Infection Control study. The study was conducted under the auspices of the Society for Healthcare Epidemiology of America, Inc and the Joint Commission on the Accreditation of Healthcare Organizations in cooper-

Table 2. Outbreaks or site-specific infections associated with nurse staffing patterns

Authors	Problem	Findings
Farrington et al, 2000[19]	6 outbreaks of methicillin-resistant *Staphylococcus aureus* (MRSA) in an ICU during 2 years	Outbreaks occurred when staffing gaps were most severe.
Haley and Bergman, 1982[20]	Clusters of staphylococcal infections in a neonatal special care unit over 2 years	Infection rate was 16 times higher after periods when the infant-to-nurse ratio exceeded 7 to 1.
Vicca, 1999[21]	MRSA cases in 1 ICU during 18 months	The incidence of MRSA was inversely correlated with nurse-staffing levels.
Harbarth et al, 1999[22]	6-week outbreak of *Enterobacter cloacae* in a 15-bed neonatal ICU	Case-control study associated infections with overcrowding and understaffing. Handwashing compliance also decreased during overcrowded, understaffed periods.
Isaacs et al, 1988[23]	Prevalence of gentamicin-resistant gram-negative organisms in a neonatal unit during 120 weeks	Increased prevalence coincided with a high nursing workload.
Fridkin et al, 1996[24]	Central venous catheter–associated bloodstream infections (BSIs)	Receiving total parenteral nutrition was the most significant risk factor for BSI. After total parenteral nutrition was controlled for, risks included increased severity of illness, days of ventilator care, days in hospital, and nurse-to-patient ratio (1:4 vs 1:2).
Archibald et al, 1997[25]	Outbreak of *Serratia marcescens* in a pediatric cardiac ICU	Increase in patient-days was associated with an increased nosocomial infection rate. There was an inverse correlation between the monthly nosocomial infection rate and nursing hours to patient-day ratio.
Robert et al, 2000[26]	BSIs in surgical ICU patients	BSIs increased at a time when nurse staffing changed to include more pool/agency nurses. Risk factors for BSI included a reduction in "regular" RN-to-patient ratio and an increase in pool/agency RN-to-patient ratio.

ation with CDC's Prevention Epicenters Program and involved 55 health care facilities.[27] The goals of the process assessment component of the study were to identify patient, practitioner-related, and organizational factors that correlate with a well-defined infection indicator across a diverse sample of intensive care units (ICUs) and to evaluate which of these factors are "alterable." Nurse staffing was not the exclusive focus of the study, but adequate staffing was identified as one factor integral to preventing bloodstream infections (BSIs). [28]

Dr Robert Gaynes provided additional data on the relationship between health care-associated BSIs and nurse staffing. BSIs are serious, common, and often preventable. The accuracy of BSI data is high.[29] Thus, hospital-associated BSIs are an excellent marker to examine the relationship. Studies seeking evidence of a relationship between nurse staffing and BSIs are, however, characterized by several problems. Data on nurse staffing are not always available or in useful form for analysis; studies generally examine only staff-to-patient ratios without controlling for the multiple other risk factors for BSIs. Studies also use different approaches and often focus on outbreaks, usually in ICUs.

A recent CDC study (submitted for publication) addresses some of these problems. The Detailed ICU Surveillance Component study, conducted December 1997 to November 1999, was a multicenter observational cohort study designed to collect information on endemic rates of central line-associated BSIs in 8 ICUs in hospitals that participate in the National Nosocomial Infections Surveillance (NNIS) System. Patient-level data were collected on more than 60 variables potentially associated with BSIs for every person admitted to these units. Nurse staffing variables included nurse-patient ratio, level of training, and permanent assignment to the unit (ICU staff nurse vs "float" nurse). "Float nurse-day" was defined as a day in which nurses caring for a patient were a mix of ICU permanent staff nurses and "float" nurses. "Percent of float nurse-days" was defined as the percentage of central line-days in which nurses caring for a patient were a mix of ICU staff nurses and "float" nurses.

Univariate analysis yielded a long list of risk factors for central line-associated BSIs. When examined with logistic regression analysis, controlling for other BSI risk factors, care by a "float" RN for more than 60% of central-line days was independently associated with an increased risk for BSI, and the risk

increased in a stepwise fashion with the proportion of "float nurse-days" of care.

DISCUSSION OF THE FINDINGS

The following points were raised during a brief discussion:

- Although staffing is shown to be associated with infection rates, "association" is not the same as "cause." Other variables include RN experience and use of temporary workers. Moreover, "failure to rescue" is generally related to hospital characteristics and not handwashing or treatment errors. These inconsistencies suggest a missing layer—a "systems" issue that has not yet been identified.
- Nursing problems are a symptom of a problem with the system. Interventions that focus on nurses do not work. Interventions that focus on the system do work. "Good hospitals" are linked to "good outcomes."[30-35]

CONSULTANT DISCUSSION AND GUIDANCE FOR THE FUTURE

The participants were asked to summarize their thoughts on the issues presented and their suggestions for strategies to move the agenda forward. The following is a synopsis of their comments.

Research perspectives

There is compelling evidence of a relationship between nurse staffing and adverse patient outcomes, despite the different approaches and backgrounds of nursing and infection control researchers. Infection control research is a focused, comprehensive undertaking that addresses a specific set of issues. The infection control community has been conducting this type of research for many years and is familiar with NNIS criteria for defining and measuring nosocomial infections. However, infection control professionals generally have little understanding of how nurse staffing works because they are often not part of a hospital's nursing division. Nursing researchers, on the other hand, often rely on large (ie, state, national) data sets for assessing patient outcomes. Infection is generally one of many outcomes of the research, and the criteria for infection may not match those used by infection control researchers or control for patient risk factors (ie, severity of illness). Nonetheless, the various studies presented yielded similar conclusions.

Future research needs to address the positive outcomes of nursing care. Currently, infection control research has a tendency to focus on the negative outcomes associated with lack of adequate nursing care. A more balanced approach would consider both.

Roles for federal agencies and professional associations in heightening national awareness of the issue

Role of the Centers for Disease Control and Prevention. Several non-CDC participants suggested that CDC/DHQP is positioned to widely disseminate information and issue advisories about the evidence of a relationship between nurse staffing and health care–associated infection outcomes, both positive and negative. Acknowledging that nurse staffing is an emerging public health problem of growing proportions that affects everyone and needs urgent attention is consistent with the DHQP-targeted health care safety challenges for the next 5 years. CDC/DHQP can also influence future research by continuing to develop and standardize methods for coding outcomes and staffing levels, and with these schema explore a minimum threshold range for staffing levels.

CDC representatives agreed that CDC/DHQP can increase the awareness of the relationship between nurse staffing and adverse outcomes. CDC also can recommend standards for coding outcomes and staffing, recommend development of an interagency task force, develop benchmarks for measurements and standards, and evaluate the impact of changes within the health care system. CDC does not, however, issue advisories; advisories are the role of JCAHO and the Centers for Medicare and Medicaid Services (CMMS, formerly Health Care Financing Administration, or HCFA).

Role of the Centers for Medicare and Medicaid Services. The representative for CMMS agreed that the agency will work collaboratively with public and private entities to support research, collect data, and further the knowledge base of nurse staffing and patient outcomes. One problem identified by the CMMS representative is the lack of a national requirement or mandate for measuring nurse staffing and outcomes. Proposed hospital regulations on this topic are currently on hold. CMMS and constituents need to work to get these approved. CMMS welcomes dialogue and action on this issue and invites an overture from CDC for creation of a public/private task force and development of an action plan. This action plan should include "advertising" of the relationship between nurse staffing and

BSIs, marketing of the message to the public in a nonsensationalist way, and making the issue specific (ie, personalizing the value of skilled, knowledgeable nurses and the effects of shortages).

The role of professional nursing organizations. Representatives from professional nursing organizations noted that the American Nurses Association and CDC/DHQP are in key leadership roles on this issue. The American Nurses Association and CDC/DHQP need to work together to develop appropriate indicators and coding specifications for BSIs and other outcomes. This issue provides an opportunity to link CDC/DHQP concerns about staffing and outcomes with established nursing quality initiatives. There are many opportunities for collaboration and for innovative public/private partnerships that can capitalize on the existing infrastructure for ongoing work. In addition, this issue links to JCAHO's staffing effectiveness initiative.* In fact, every federal agency and professional health care organization is a stakeholder in the nursing shortage.

CURRENT SITUATION AND POTENTIAL SOLUTIONS

Several participants commented that the problem of nurse staffing is complicated, and the old ways no longer work. Regulatory and accreditation agencies initiate changes, but these changes are unlikely to solve problems related to organizational systems/culture. We need to change our thinking, our audiences, and our language, as well as our corporate culture and where nursing fits into it. Several participants commented that nurses are health care providers who have been ignored and that RNs are "knowledge" workers who are viewed as employees of convenience. Researchers and policymakers need to use a cost-benefit argument to show why prevention of adverse events is important. Fundamental change is needed at the hospital level. For example, the "float" nurse problem is an offshoot of the current hospital environment, which is characterized by chaos, anger, and lack of clarity about a mission. This results in overwhelming pressures, increased demand that nurses work overtime, fear of error and reprisal, a "union mentality," risk aversion, lack of support among nurses for one another, and apathy. This is an unhealthy culture. There are ways to measure culture and act on findings. This is a much larger issue than simply that of nurse staffing and outcomes.

*JCAHO is adding a new standard, effective July 1, 2002, that requires health care organizations to use data on clinical/service and human resources screening indicators to assess staffing effectiveness. Additional information on the standard and its related indicators is available online at http://www.jcaho.org/standard.

CDC RESPONSE AND NEXT STEPS

Gerberding agreed with the discussants that the system is broken and chaotic but acknowledged that "the system is us." Although finding a solution seems an overwhelming task, actions need to be taken. We need to enhance understanding of the problem but avoid preaching to the choir. The next steps are to expand the group of stakeholders, with a focus on patients, and foster a "convergence of information" on nursing, staffing, and adverse events to inform these stakeholders and the public. This article is the first step.

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*A comprehensive list of references on nurse staffing and health care-associated infections is available online at http://www.cdc.ncidod/hip/.

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APPENDIX

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